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# DESCRIPTION OF THE MATURE FEMALE AND EPICARIDIUM LARVA OF *CABIROPS MONTEREYENSIS* SASSAMAN FROM SOUTHERN CALIFORNIA (CRUSTACEA: ISOPODA: CABIROPIDAE)

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*Abstract.*—The cryptoniscoid isopod *Cabirops montereyensis* Sassaman, previously known only from Monterey Bay, California, has been collected at Malibu, California. Diagnostic characters of the cryptoniscus larva are illustrated with scanning electron microscopy and the mature female and epicaridium larva are described. The mature female exhibits characteristics typical of most species in the genus, especially those parasitic on pseudionine bopyrids. The epicaridium larva differs from other described Cabiropidae in details of the appendages and in the possession of a prominent anal tube.

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*Cabirops* Kossmann, 1884 is a genus of hyperparasitic isopod crustaceans that are brood parasites of bopyrid isopods which are, in turn, branchial parasites of decapod shrimps and crabs. *Cabirops* has a complex taxonomy stemming from confusion about the relationship between it and *Paracabirops* Caroli, 1953, which is now considered a junior synonym (Restivo 1975), and from the number of unnamed species which have been assigned to this genus. I have reviewed the nomenclature of the fifteen described species of *Cabirops* elsewhere (Sassaman 1985) and follow those conventions here; the superfamily nomenclature has been reviewed recently by Grygier & Bowman (1990, 1991).

Although the genus is widespread in its occurrence throughout the world, only one species, *Cabirops montereyensis,* has been described from the entire eastern Pacific Ocean. Its known distribution has been limited to Monterey Bay, California; previous collections of its definitive host, *Aporobopyrus muguensis,* parasitizing porcellanid crabs of the genus *Pachycheles* in central and southern California did not yield this species (Sassaman 1985).

I have found specimens of *Cabirops* in four *Macrocystis* holdfasts collected at Malibu, California, over the last three years. Comparisons of cryptoniscus larvae and immature females between these collections and those from Monterey Bay indicate that the southern California specimens represent a range extension of *C. montereyensis.* The diagnosis of the cryptoniscus stage is illustrated, and supplemented by descriptions of several new characters, based on scanning electron microscopy.

Neither the mature female nor the epicaridium stage of *C. montereyensis* has been described. The southern California collections include a mature female brooding epicaridium stage larvae; these stages are described and compared with similar stages in other species.

Superfamily Cryptoniscoidea Kossmann, 1880
Family Cabiropidae Giard & Bonnier, 1887
*Cabirops* Kossmann, 1884
*Cabirops montereyensis* Sassaman, 1985
Figs. 1A–I, 2, 3A–H, 4A–I

*Materials examined.*—Specimens from southern California were extracted from

*Macrocystis* holdfasts collected by Rimmon C. Fay (Pacific Bio-Marine Laboratories) at Malibu, California, at depths from 8 to 10 m as follows: 8 Jan 1988, 1 cryptoniscus larva from branchial cavity of *Pachycheles holosericus* parasitized by an unpaired female *Aporobopyrus muguensis*; 22 May 1989, 1 cryptoniscus larva found free in residue from holdfast; 2 May 1990, 1 cryptoniscus larva and 1 immature female in marsupium of 1 unpaired *A. muguensis* and 2 cryptoniscus larvae and 2 females (1 immature and 1 mature) in marsupium of second (paired) *A. muguensis,* each bopyrid in branchial cavity of *P. holosericus,* 11 additional *A. muguensis* unparasitized; 4 February 1991, 9 cryptoniscus larvae on 1 paired *A. muguensis* in branchial cavity of *P. holosericus,* 6 additional *A. muguensis* unparasitized.

All material was fixed in 70% ethanol except the cryptoniscus collected in May 1989 and six cryptoniscus larvae collected in February 1991, which were fixed in 3% glutaraldehyde in sea water. The May 1989 specimen was subsequently prepared for scanning electron microscopy (SEM) with the protocol of Nielsen & Strömberg (1973a), gold-palladium coated, and examined with a Philips 515 microscope. Epicaridium larvae were dissected from the marsupium of the mature female and prepared for SEM by the same procedure.

The 3 females collected on 2 May 1990, their accompanying males, bopyrid hosts, and decapod hosts have been deposited with the Los Angeles County Museum of Natural History under catalog number LACM 90-90.

*Cryptoniscus larva.*—Comparison of the cryptoniscus larvae from Malibu with material from Monterey Bay indicates that the southern California specimens are *Cabirops montereyensis.* Diagnostic characteristics of *C. montereyensis* that are also present in the new material include the configuration of the lateral dentition of the 2nd article of the 1st antenna (Fig. 1A), the shapes and distributions of the coxal plate denticles (Fig. 1B), the setal comb on the dactyl of peraeopod III (Fig. 1C), the bifid dactyls of peraeopods VI (Fig. 1D) and VII, and the branched setae at the base of the uropodal endopod (Fig. 1E). The fused mouthparts of the oral cone are shown in Figure 1F. I previously characterized the medial setae arising from the pleopodal sympods as simple; they actually terminate in a trifid process, the middle tine being barbed (Fig. 1G) as illustrated by Goudeau (1970) for *Hemioniscus balani* and Nielsen & Strömberg (1973b) for *Parapodascon stebbingi.*

To the previous description of this stage (Sassaman 1985) I add that the dorsal cuticle of the head has scattered circular depressions containing a single, central, short cilium (Fig. 1H) reminiscent of structures mentioned by Nielsen & Strömberg (1973a) and recently described by Bocquet-Védrine (1985) in *Crinoniscus equitans.* In addition, the dorsal surface of the cephalon and the pre-antennal ventral surface contain rows of circular button-like structures (Fig. 1H, I) which are easily observed as dark circles under highly polarized bright light. Although initially identified as glandular secretions in *Cironiscus dahli* on the basis of azocarmine-positive histological staining (Nielsen & Strömberg 1965), these structures clearly have a morphological basis in *Cabirops montereyensis* (Fig. 1H, I) and are evident in SEMs of several other cryptoniscoid species (Nielsen & Strömberg 1973b). Their function and their taxonomic usefulness have yet to be determined.

*Mature female.*—The 2 immature females collected 2 May 1990 correspond in morphology with the Stage A and Stage B females previously illustrated (Sassaman 1985). This similarity further supports the identification of the southern California specimens as *Cabirops montereyensis* which, in the immature female stages, differs from other described species of the genus (Sassaman 1985). Only the mature female (Fig. 2) is described here.

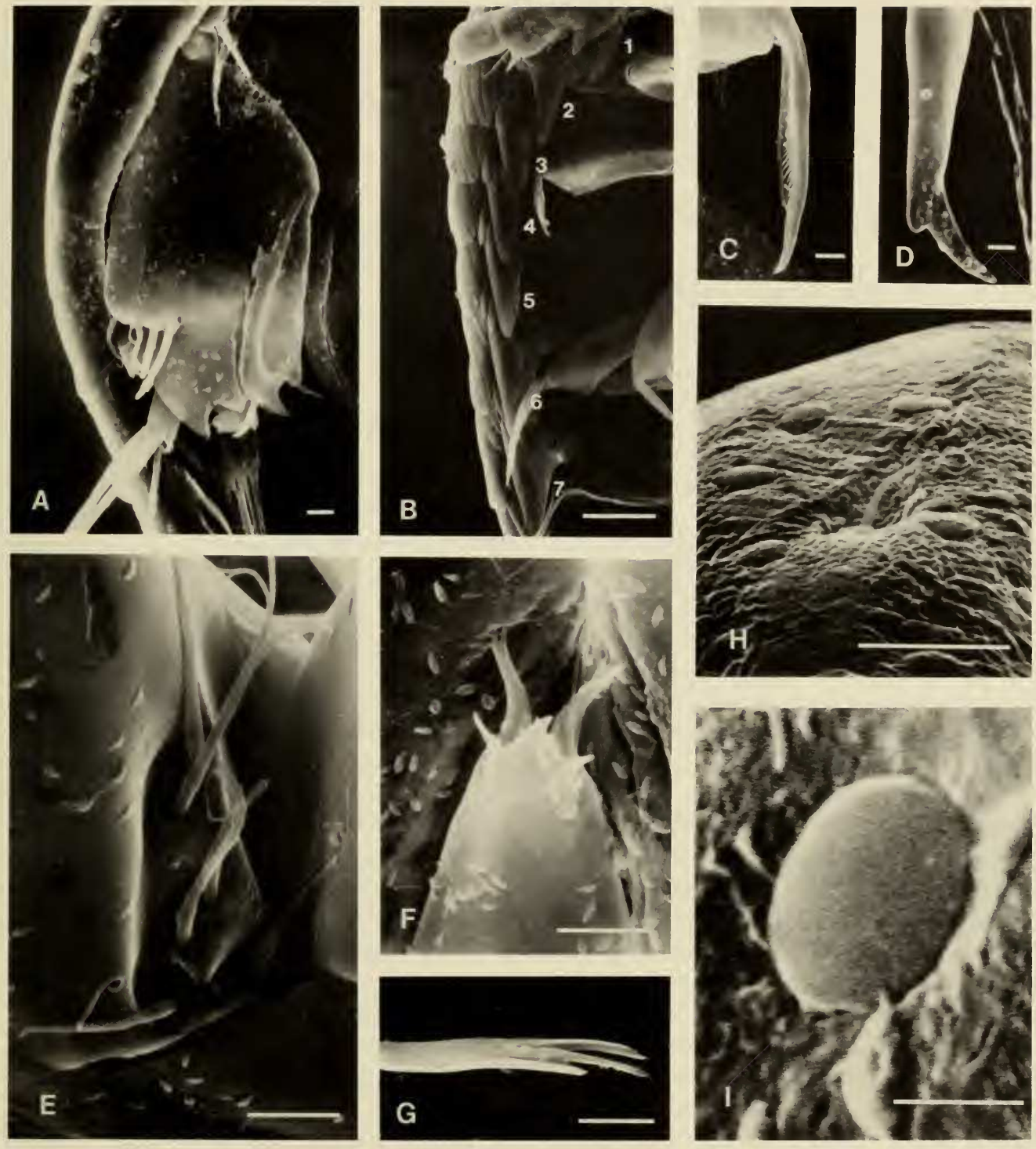


Fig. 1. *Cabirops montereyensis,* cryptoniscus larva. A, Second article of the first antenna; B, Coxal plates of peraeonal segments I–VII; C, Dactyl of peraeopod III; D, Distal tip of dactyl of peraeopod VI; E, Lateral margin of the uropodal endopod at its base; F, Oral cone; G, Distal tip of medial seta of pleopodal sympod 1; H, Sensory pit on dorsal surface of the cephalon at anterior margin; I, Detail of cephalic birefringent button. Scale bar in B = 50 μm; scale bars in A, C, E, F, G, and H = 5 μm; scale bars in D and I = 1 μm.

Description: Body strongly flexed ventrally into U-shape. Maximum dimension in flexed state 1.8 mm; total length (if unflexed) approximately 2.8 mm. Entire body filled with hatched epicaridium larvae. Cephalon indicated by paired cephalic plates and cup-shaped cephalic appendages projecting forward. Peraeon indicated dorsally by 7 regions each delimited by chitinous transverse ribs and cuticular creases. Perae-

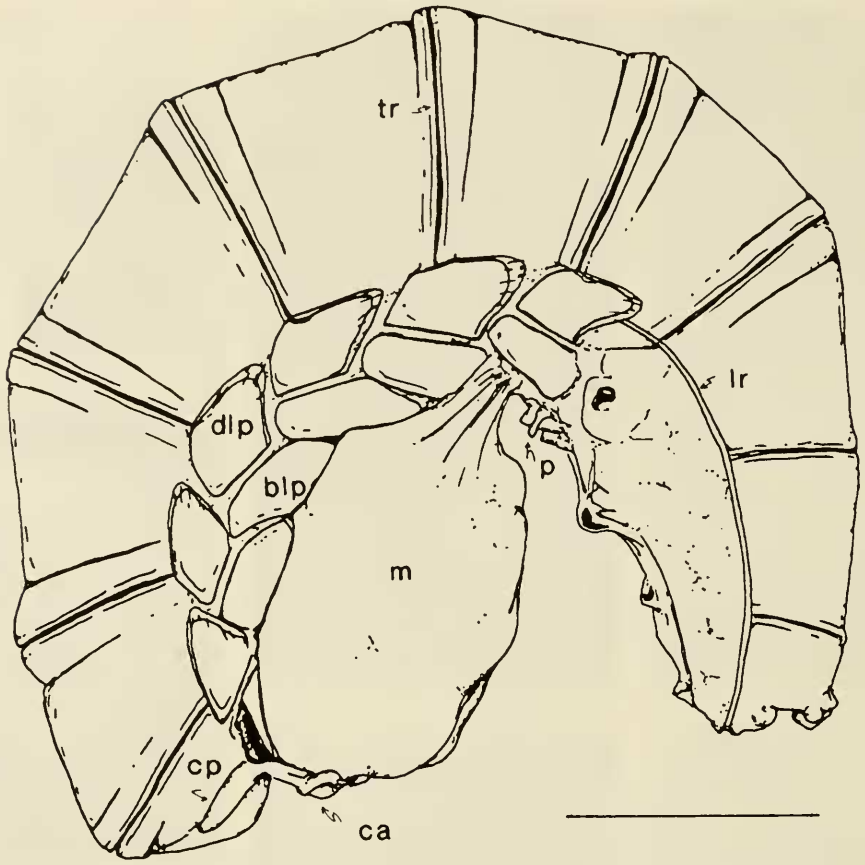


Fig. 2. *Cabirops montereyensis,* mature female. cp, cephalic plate; ca, cephalic appendage; blp, basal lateral plate; dlp, distal lateral plate; tr, transverse rib; lr, longitudinal rib; m, marsupium; p, papilla. Scale bar = 0.5 mm.

onal segments also indicated by 6 lateral-plate complexes composed of 2 elements, basal plate attached laterally and distal plate projecting postero-dorsally and partially free. Two large, laterally expanded, ventral lobes (marsupium) attached to peraeonal region. Small papilla extending ventrally on each side from last peraeonal segment. Pleon with 3 regions demarcated by transverse chitinous ribs, dorsal and ventral pleonal regions separated by prominent longitudinal chitinous rib. Ventral border with several irregular swellings. Pleon approximately 1:3 total body length.

Remarks: Adult females have been described previously for eight other species of *Cabirops*: *C. perezei* (Carayon 1942a), *C. marsupialis* (Caroli 1953, Reverberi & Catalano 1963, Restivo 1975), *Cabirops* sp. (Romano 1953, Attardo 1955), *C. codreanui* (Bourdon 1966), *C. ibizae* (Bourdon 1966), *C. pseudione* (Lemos de Castro 1970), *C. lobiformis* (Lemos de Castro 1970), and *C. reverberii* (Restivo 1971). Five features that are common to *C. montereyensis* and all but two of these species are: the body is ventrally flexed and has a characteristic U-shape in lateral view; laterally paired ventral swellings of the peraeonal region form a marsupium; six lateral plate-like processes are associated with the peraeon; traces of peraeonal segmentation are marked by transverse chitinous ribbing; and transverse segmentation of the pleonal region is indicated by dorsal and ventral regions separated by longitudinal ribbing.

One species, *C. perezei,* lacks obvious lateral plates and a marsupium. It is possible that the most advanced female described by Carayon (1942a), although brooding eggs, is not fully mature and therefore does not completely express the adult characters; the female he described subsequently (Carayon 1942b) is clearly not fully mature. Alter-

natively, *C. perezei* may represent a somewhat derived form; it is, for example, the only *Cabirops* in which eyes are lacking in the cryptoniscus stage. The second exception to the general pattern of adult female characters is *C. lobiformis,* which shows none of the typical characteristics of mature female *Cabirops.* Females of two additional species have been described: *C. lernaeodiscoides* (Kossmann 1872) lacks the marsupium and *C. tuberculatus* (Shiino 1942) resembles *C. lobiformis* in lacking most of the typical characteristics of mature females. Both of these descriptions probably are of immature females.

I have suggested, based on cryptoniscus morphology, that *Cabirops* may include two groupings of species, one associated with pseudionine and orbionine hosts and the other associated with bopyrine and ionine hosts (Sassaman 1985). Mature females of all species known from pseudionine hosts have been described and only *C. perezei* deviates from the general pattern of characteristics enumerated above. In contrast, adult females of species parasitic on ionine and bopyrine hosts are less well known, but it is within this group that the most notable exceptions in female morphology occur, e.g., *C. lobiformis* and perhaps *C. tuberculatus.* Further descriptions of *Cabirops* from these latter two host subfamilies are much needed to clarify this hypothesis of intrageneric heterogeneity. The *Cabirops* sp. parasitic on *Bopyrina ocellata* is a case in point. This species has been confused with *C. marsupialis,* a parasite of *Gyge branchialis,* and mature females have been differently described by Romano (1953) and Attardo (1955). Although Romano's illustration of the mature female (reproduced also by Attardo [1955]) does not show the chitinous ribbing and lateral plates, they are nevertheless evident in Attardo's (1955, fig. 11) photograph of the spent female. Clarification of the status of these bopyrine parasites may also have bearing on the affinities of *Cabirops* to *Bourdonia* Rybakov, 1990, a *Cabirops*-like genus recently described from *Bopyroides hippolytes.*

Among those species parasitic on pseudionine bopyrids, and showing the typical suite of *Cabirops* characters, there is, nevertheless, subtle variation in morphological features. Not all descriptions have indicated the presence of cephalic plates and cephalic appendages, and the relative size and the degree of segmentation of the pleon varies considerably (e.g., Bourdon 1966; Restivo 1971, 1975). The small papilla on the ventral surface of the peraeon of *C. montereyensis* appears to be unique.

*Epicaridium larva.*—General body form: in dorsal aspect of slightly flattened specimens, body drop shaped, widest at peraeonal segment V. Length measured from anterior edge of cephalon to posterior border of telson about 200 μm. Second antennae (excluding terminal spines) extending to pleonal segment 1.

Cephalon: Broadly rounded, dorsal cuticle smooth. No trace of eyes. Antenna 1 with 3 articles (Fig. 3A). Basal article incompletely resolved, but bearing at least 1 branched seta at antero-lateral corner. Second article simple, with 3 branched setae at distal edge. Third article biramous, dorsal branch simple with 2 terminal spines, ventral branch with 1 articulation, distal part bearing 3 terminal spines. Two aesthetascs originate at base of 3rd article. Antenna 2 of 5 articles (Fig. 3B): 2 peduncular, 3 flagellar. Distal peduncular article (Fig. 4B) with 4 setae: 3 dorsomedial (2 branched), 1 terminal. Two stout spines at distal ends of first 2 flagellar articles. Distal flagellar article with 4 short, smooth, terminal spines, and 2 longer ones with regular rows of short spinules along most of distal part, spinules more developed on shorter (outermost) of these spines (Fig. 4C) than on inner one (Fig. 4D). Mandibles terminating in row of bicuspid teeth forming grinding surface flanked laterally by cylindrical processes bearing terminal pores (Fig. 4E).

Peraeon: 6 segments with appendages.

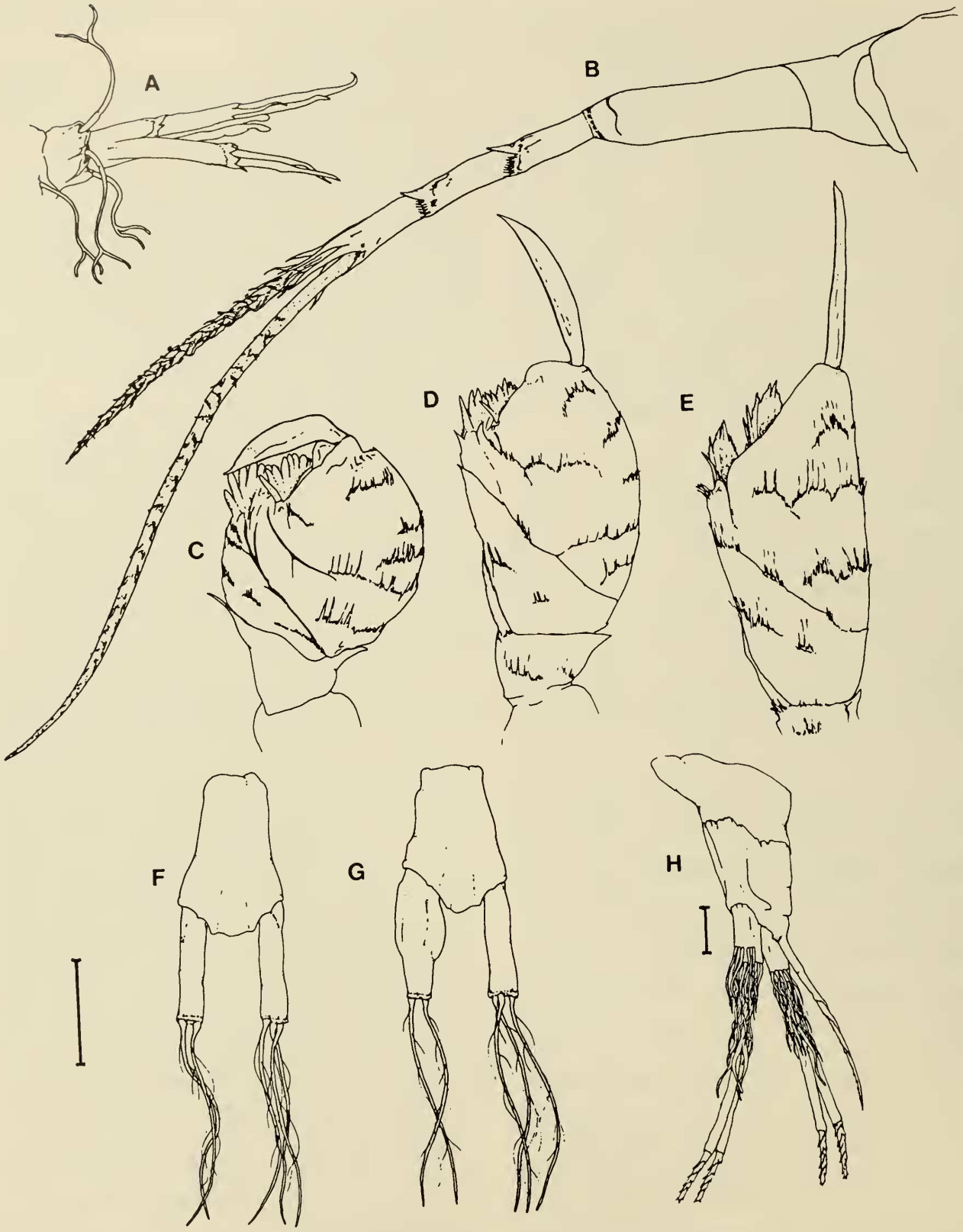


Fig. 3. *Cabirops montereyensis,* epicaridium larva. A, Antenna 1; B, Antenna 2, ventral view; C, Peraeopod I; D, Peraeopod V; E, Peraeopod VI; F, Pleopod 1; G, Pleopod 5; H, Uropod. Scale bars = 10 μm. (A–G are to the scale shown at the lower left of the figure.)

Each peraeopod with 6 articles, but carpus broadly fused to propodus on all peraeopods forming propodocarpal complex. Peraeopods I and II with bulbous propodocarpal complex (Fig. 3C), peraeopods III–V with more elongate complex, ending almost squarely (Fig. 3D), peraeopod VI with longest complex, tapering distally (Fig. 3E).

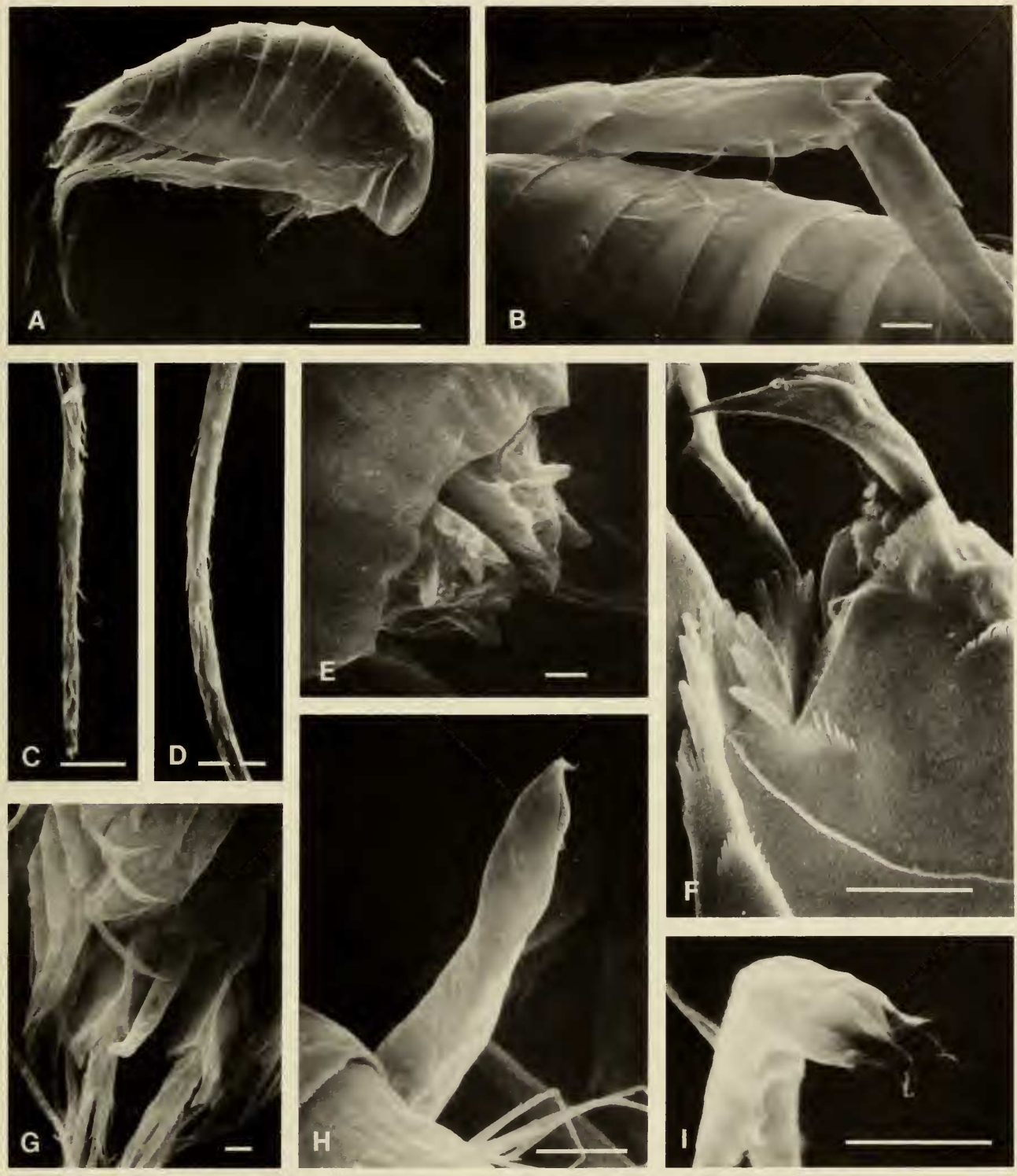


Fig. 4. *Cabirops montereyensis,* epicaridium larva. A, Lateral view, intact larva; B, Dorsal view of the distal penduncular article of Antenna 2; C, Outer terminal spine of antenna 2; D, Inner terminal spine of antenna 2; E, Mandibles; F, Distal tip of peraeopod V; G, Pleon with insertion of anal tube; H, Anal tube; I, Detail of terminal hairs of anal tube. Scale bar in A = 50 μm; scale bars in B, C, D, F, G, H, and I = 5 μm; scale bar in E = 1 μm.

Dentate shields on propodus and on distal tip of carpus on all peraeopods (Fig. 4F). Basis elongate on peraeopod VI.

Pleon: 5 pairs of biramous pleopods. Sympods lacking medial processes and progressively decreasing in length from pleopod 1 (Fig. 3F) to pleopod 5 (Fig. 3G). Exopods and endopods of similar length on all pleopods. All exopods with 3 terminal spines and all endopods with 2 terminal spines

bearing fine setae. Uropods (Figs. 3H, 4G) robust. Protopod bearing lateral plumose spine, exopod with 3 spines (2 plumose) and endopod with 5 spines (2 plumose). Medial margins of uropodal endopod and exopod with fine hairs (Figs. 3H, 4H). Prominent anal tube originating at base of uropods (Fig. 4G), often projecting ventrally or anteriorly (Fig. 4H), terminal opening ringed with fine hairs (Fig. 4I).

Remarks: Previous descriptions of *Cabirops* epicaridium larvae (Romano 1953, Attardo 1955, Reverberi & Catalano 1963) are too fragmentary and imprecise to permit valid comparison with the larvae of *C. montereyensis.* Larvae of two other genera of Cabiropidae have been described in sufficient detail to permit general comparison: *Ancyroniscus bonnieri* (Holdich 1975) and *Clypeoniscus meinerti* (Giard & Bonnier 1895). These species differ from *C. montereyensis* in details of antennal, peraeopodal, and pleonal structures and both are characterized by very short anal processes. Similar generic level differences occur in the degrees of development of the anal tube within the Cryptoniscidae; it is prominent in *Liriopsis* (Caullery 1908), *Crinoniscus* (Pérez 1900, Boquet-Védrine 1987), and the enigmatic *Enthylacus* (Pérez 1920), but is lacking in *Danalia* (Caullery 1908, Fize 1955). The anal tube is well developed in *Hemioniscus balani,* the single species of Hemioniscidae in which the epicaridium stage has been described (Caullery & Mesnil 1901).

The only cryptoniscoid epicaridium that has been described in sufficient detail for precise comparison with *C. montereyensis* is *Crinoniscus equitans,* illustrated extensively by Bocquet-Védrine (1987). The two species are remarkably similar in the overall shapes of appendages and in the distribution and form of various spines and setae. Although there are differences in details of the second antennae, peraeopods, and pleopods, these differences are rather subtle. The salient difference between the two species is in the configuration of the uropods, slender and elongate in *C. equitans* and robust in *C. montereyensis.*

Uropodal morphology of epicaridia likely represents a familial character distinguishing Cryptoniscidae (Bocquet-Védrine 1987) from other families of Cryptoniscoidea. To what extent other differences in epicaridium morphology might represent characters of systematic value presently is unknown. This stage may be useful in future work in providing an additional suite of specific characters (as has been indicated for the bopyrid genus *Probopyrus*—Dale & Anderson 1982) and also, perhaps, in providing higher level characters which may aid in more firmly resolving the systematics of this superfamily.

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